Space Weather Technical Forecast

Issued on Wednesday, 09 March 2022 at 12:31 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance of G1 Minor Geomagnetic Storms. Chance of M-class flares. Active fluence.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity was Low over the period, with activity confined to isolated low C-class flares. There are five sunspot regions on the visible disc. AR2965 is likely to be complex, but currently is too close to the northeast limb for clear analysis. AR2960 remains the largest region, although it has faded slightly. AR2964 has some magnetic complexity and has grown over the last 24 hours. The remaining regions are small and weak.
There were no new Earth directed CMEs seen in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, was characteristic of a waning connection to a negative polarity high speed stream, probably that from CH61/- and 62/-. The solar wind speed started near 450 km/s, and decreased to around 400 km/s. The density was mostly below average. The IMF, Bt, was weak below 5nT, while the north-south component, Bz, varied weakly but was predominantly negative. The phi angle was mostly negative (towards the Sun). The corresponding geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at Background levels. The high energy electron flux (greater than 2 MeV) was High throughout, with a peak value of 4769 pfu at 08/1800UTC. The corresponding 24-hour integrated electron fluence remained above the Active level, on a mostly level trend. The 09/0000 UTC observation was 2.15e8 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is likely to be Low, with further isolated C-class flares expected and a chance of M-Class activity, mainly from AR2965.

Solar Wind / Geomagnetic Activity: There are two low confidence CMEs in the forecast, and latest modelling suggests they may start to merge and arrive very close together. It now appears most likely they will arrive during Day 2 (10 Mar), with the CMEs emitted on the 6th and 7th respectively.
Geomagnetic activity is expected to be initially Quiet to Unsettled (Kp 0-3). If we see the CME(s) then activity is likely to become Unsettled to Active (Kp 3-4) during Day 2, with a slight chance of G1/Minor Storm (Kp 5) intervals, with activity gradually declining through Days 3 and 4 (11-12 Mar). In the absence of CME effects, activity is expected to be mainly Quiet.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels, albeit with a very slight and increasing daily risk of S1. The high energy electron flux is expected to persist at High levels on a slowly declining trend in the absence of CME effects, but with a chance of drop-out from either CME arrival. The associated 24-hour fluence is expected to follow a slowly declining trend through much of the period, but with increased uncertainty due to the potential CMEs.

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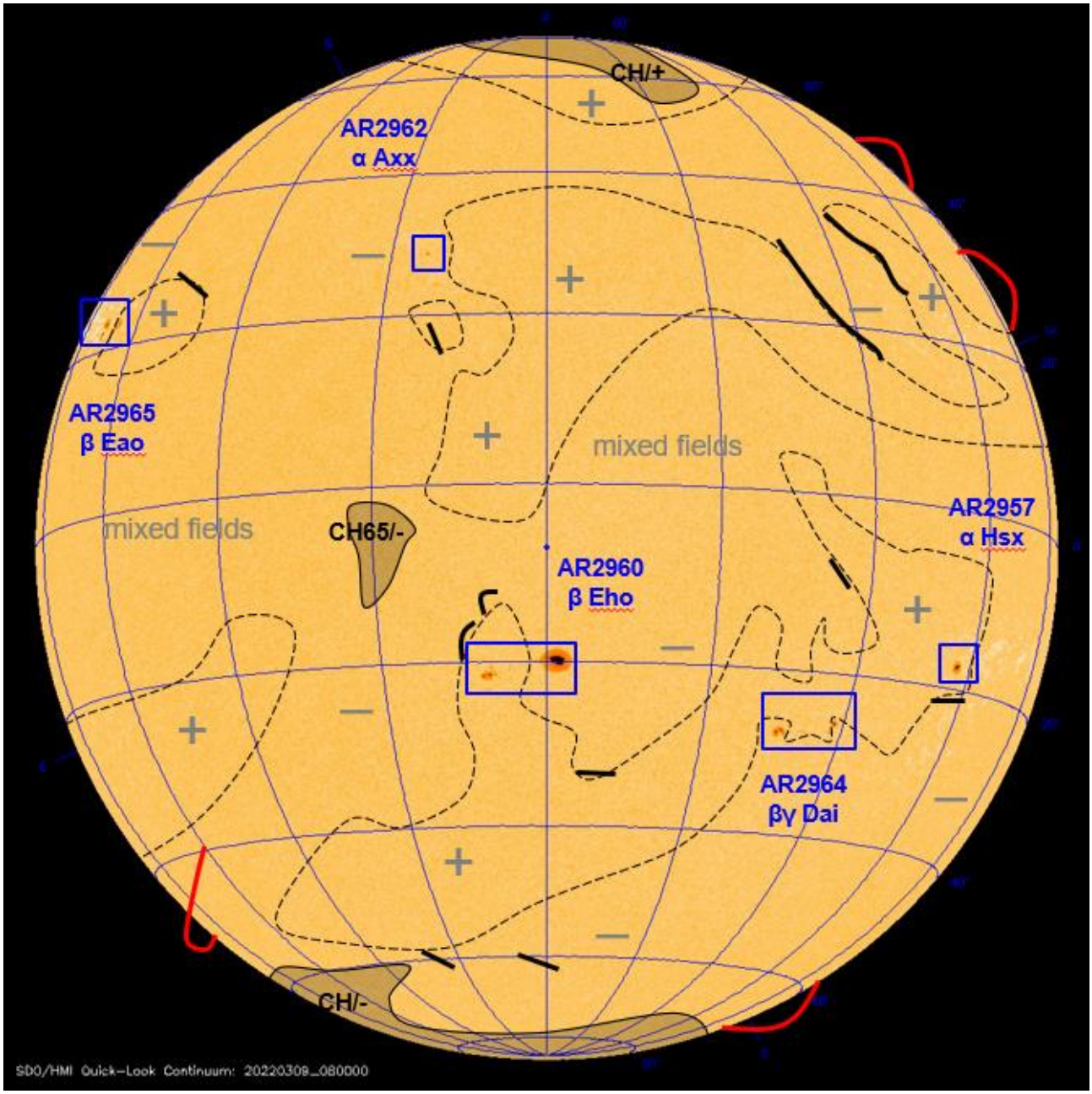
Figure 1. Solar Analysis Valid 09/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two low confidence CMEs in the forecast, and latest Enlil modelling suggests they may start to merge and arrive very close together. Initially the first CME was expected to arrive late on Day 1 (09 Mar), but it now appears most likely they will both arrive during Day 2 (10 Mar), with the CMEs emitted on the 6th and 7th respectively.

There are no coronal holes expected in the period, with the previously recurrent coronal hole from last rotation no longer visible on this rotation.

Geomagnetic activity is expected to be initially Quiet to Unsettled (Kp 0-3). If we see the CME(s) then activity is likely to become Unsettled to Active (Kp 3-4) during Day 2, with a slight chance of G1/Minor Storm (Kp 5) intervals, with activity gradually declining through Days 3 and 4 (11-12 Mar). In the absence of CME effects, activity is expected to be mainly Quiet.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	20	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
06/0650	Partial	Unknown	N04E15	224 km/s	After 09/2100 UTC	Very low confidence, with uncertain source.
07/0920	Partial	Ex-2958	N10W24	417 km/s	10/2100 UTC	Good confidence, but only glancing impact likely.

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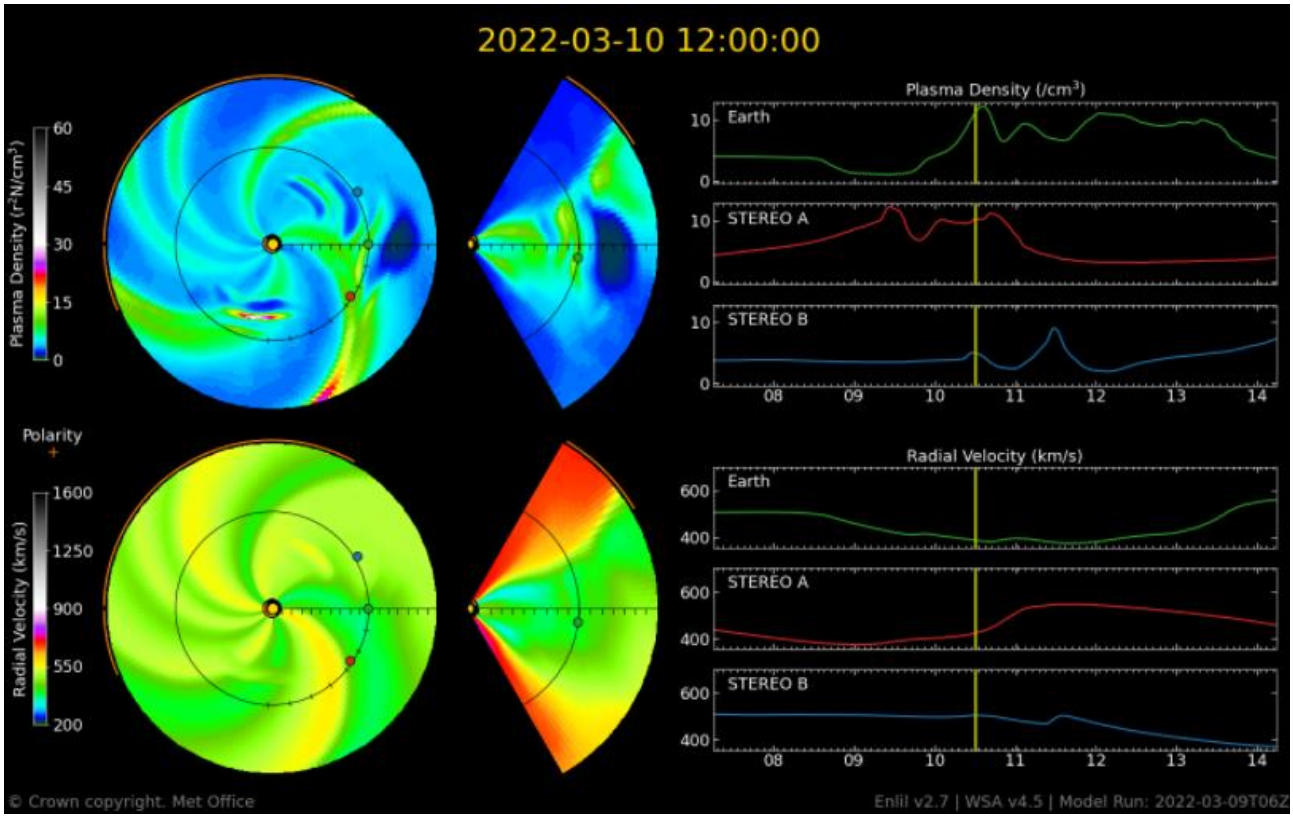
Figure 2: Recent Enlil modelling suggesting a possible merging of the two CMEs, with arrival during Day 2 (10 March).



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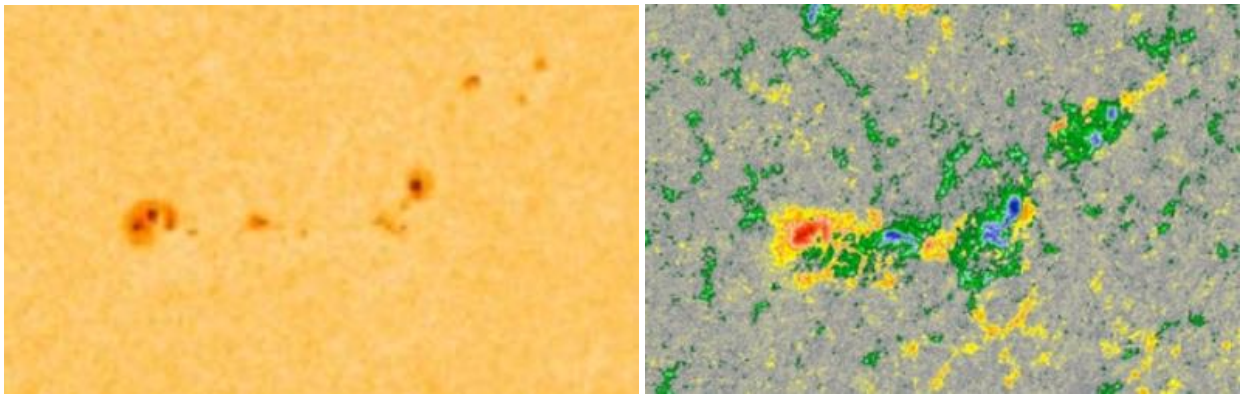
Radio Blackouts - X-Ray Flares:
There are currently five sunspot regions on the visible disc. AR2965 (Eao/Beta) appears to be the most likely flare risk, and has given most of the recent low level activity. This region has recently rotated onto the NE limb, so it is still difficult to classify, but it appears to have some magnetic complexity. AR2960 (Eho/Beta) is the largest region on the disc but is stable and has faded slightly in recent hours. AR2964 (Dai/Beta-gamma) is the most interesting magnetically as it has the opposite polarity from that expected in a southern hemisphere sunspot, with a positive leading spot and negative trailing. It has given one minor C-flare, but perhaps has potential for a larger flare. The other regions are small and weak.

Far side soundings and EUV imagery from STEREO suggest there may be two returning regions at the end of the forecast period, although the contribution of these is not yet considered.
Activity is expected to remain Low with C-Class flares expected and a chance of M-flares, these most likely from AR2965.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: SDO intensitygram and magnetogram imagery showing the unusual magnetic setup of AR2964, with positive polarity leading (normally negative leading in the southern hemisphere during this solar cycle).



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (10MeV) measured at GOES 16 is currently at Background levels. The raw probabilities for S1 or above suggest a very low but 'measurable' risk at present, which should increase slightly through the four days - mainly the result of AR2960's imminent arrival into the western hemisphere and the unusual magnetic setup of AR2964.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	3	3	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

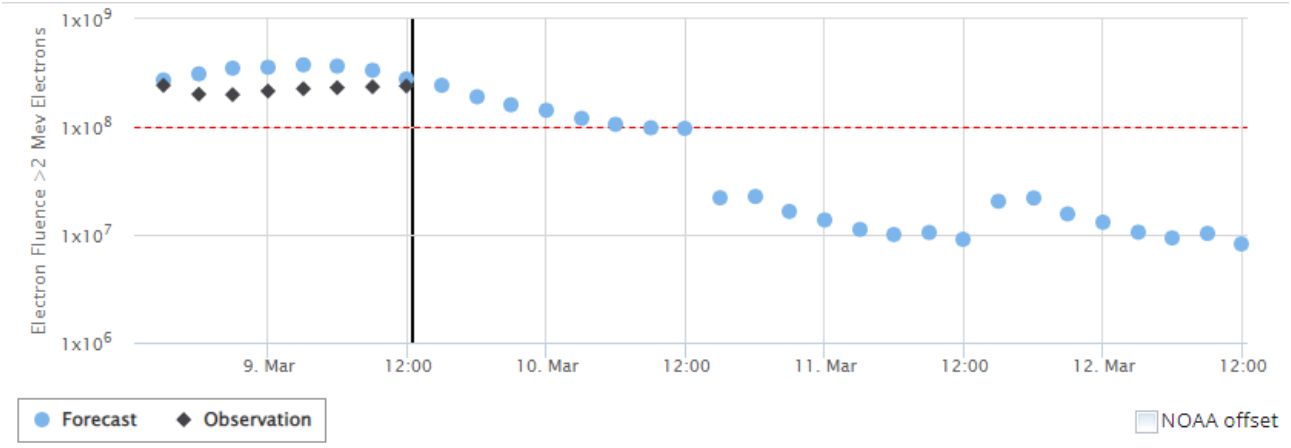
The high energy (2 MeV) electron flux is currently at High levels. However, there is a chance of two CME arrivals during Day 2 (10 Mar), although these are low confidence. Should one or both of these occur, electron flux is expected to drop out. As such, the electron forecast is low confidence due to the uncertainty in the CME arrivals. In the absence of CMEs, a slowly declining trend is expected.

The associated 24-hour fluence is currently above the Active threshold (1e8 integrated pfu), but may decline sharply if we see either CME arrive. Otherwise, a slow decline is most likely.

The REFM model does not assimilate data associated with possible CME arrivals, so it is not expected to be giving good guidance at the current time. It is also considered to be reducing the fluence too quickly if the CME(s) do not occur.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	80	40	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: REFM showing a reasonably fast declining trend in fluence. This doesn't take account of any potential sharp dropouts due to CME arrivals. It is also likely to be declining too fast in the absence of CME influence.



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